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AN EVALUATION OF THE STATE-OF-THE-ART IN OUTDOOR RECREATION SUPPLY AND DEMAND ANALYSIS FOR MULTIPLE USE LAND MANAGEMENT AGENCIES

An Evaluation of the State-of-the-Art in Outdoor Recreation Supply and Demand Analysis for Multiple Use Land Management Agencies

by

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EXPERIMENT STATION

INTRODUCTION

Identification of the optimal recreation output levels, as with other commodities, requires an objective appraisal of relative scarcity. Furthermore, to adequately describe scarcity of recreation relative to that of other commodities such as wood fiber, domestic livestock forage, etc., an index of relative scarcity must be avaliable. Any rational decision model involving multiple outputs suggests the need for these types of information. A particularly useful reference to the types of "decision model" requirements suggested here is contained in the language of the Forest and Rangeland Renewable Resources Planning Act (RPA). One RPA requirement is:

> (1) an analysis of present and anticipated used, demand for, and supply of the renewable resources, with consideration of the international resource situation, and an emphasis of pertinent supply and demand and price relationship trends. (Sec. 2)

This paper attempts to develop a statement of the "state-of-the-art" in the analysis of recreation as a scarce commodity. Specifically, an attempt is made to review the existing literature on recreation demand, valuation, and supply analysis. Major emphasis is given to U.S. Forest Service problems and legislation in developing the context of the state-of-the-art presentation, but development of the state-of-the-art review drew upon widely varying sources.

Within "demand analysis," projections are called for which will be useful in developing resource plans. The foundation of this requirement for projected future consumption is found in the definition of Multiple Use in the MUSYA:

> the management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people. (Sec. 4)

And, this is re-stated in the NFMA as:

> the Forest Service . . . has both a responsibility and an opportunity to be a leader in assuring that the Nation maintains a natural resource conservation posture that will meet the requirements of our people in perpetuity. (Sec. 2)

Thus, development of projections of these "needs," or "requirements" is paramount in fulfilling legislative requirements.

The demand analysis called for clearly involves more than consumption projection, however. In the MUSYA (again, in the definition of Multiple Use) the Forest Service is called upon to practice:

> management . . . with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output. (Sec. 4)

And, in the RPA it is required to develop:

> specific identification of Program outputs, results anticipated, benefits associated with investments in such a manner that the anticipated costs can be directly compared with the total related benefits and direct and indirect returns to the Federal Government. (Sec. 3)

It appears that demand analysis should include or be consistent with valuation (estimation of value indexes) of the renewable resources to be considered. Furthermore, it is clear that one intent of the new Regulations for Land and Resource Management Planning in the National Forest System is to require economic efficiency analysis in all Forest System plans. This will involve applied welfare economics such as benefit-cost analysis.

Within the "supply analysis," two types of approaches are also called for. First, to go along with the "use projections," present facilities need to be inventoried in terms of capacity. Projections of this capacity under different assumptions concerning Forest Service area development must be and have been employed to indicate future consequences of those different assumptions. This approach is described in the RPA requirements as:

> (2) an inventory, based on information developed by the Forest Service and other Federal agencies, of present and potential renewable resources, and an evaluation of opportunities for improving their yield of tangible and intangible goods and services, together with estimates of investment costs and direct and indirect returns to the Federal Government. (Sec. 2)

Second, to go along with the value or benefit estimation in the "demand analysis," a cost estimate is also necessary to complete benefit-cost analysis (or its equivalent). In this context, the supply analysis essentially amounts to determination of a marginal cost curve which will serve as a supply curve surrogate.

It is important to maintain this distinction between the two approaches. The use and inventory analysis is useful in determining and foreseeing large scale congestion or excess capacity in recreation areas. The benefit and cost analysis is useful in analyzing economic efficiency. The purpose of this paper is to evaluate the state-of-the-art in both approaches.

OUTDOOR RECREATION PARTICIPATION

Over the years, a number of studies have attempted to project recreation participation levels for both regions and the entire nation (Outdoor Recreation Resources Review Commission, 1962, 1965; Kalter and Gosse, 1969; Cichetti, Seneca, and Davidson, 1969; Adams, Lewis, and Drake, 1973; Hof and Kaiser, in press). It is generally agreed that these are not true demand projections in the economic sense. It has been postualted that the purpose of recreation participation projections is not that of creating an economically efficient allocation of forest resources, but simply that of anticipating large scale over-use or congestion of future recreation resources. Participation projections are thus in terms of actual consumption levels to be expected, given: exogenously determined costs of consumption; supplies of recreation opportunities; and other demand shifter values. The general approach commonly taken in projecting recreation participation is to identify a predictive participation function, and apply projections of the arguments of that function in order to arrive at expected future participation levels. A simpler alternative would be to extend the recent trend in participation into the future. This simple approach is often rejected for two potential reasons: (1) such an approach relies on the additional assumption that trends in all determinants of participation will remain constant in the future, and (2) it is useful to know not only the magnitude of a participation projection, but also the reasons for that projection magnitude and path. If the trend in one of the arguments of the participation function should unexpectedly change in the near future, the importance of that event would be unknown with nothing but a simple time-trend of participation available.

It might be further noted that the data necessary to identify such a time trend might not be available. For example, the National Recreation Surveys[1] provide cross-sectional information for each of the dates of data collection (1960, 1965, 1972, 1977), but comparisons and trend analysis would be difficult or impossible due to the substantive inconsistencies in these surveys. The Kirschner Report (1975) provides an excellent discussion on the consistencies and inconsistencies of these survey efforts. The only other source of National participation information might be the use estimates made by the various land use agencies.[2] Since each agency uses different units of measure of use, construction of national projections would be quite difficult.

THE METHOD

The basic methodology typically used to project the number of participants in specific activities in the Nation can be described in four steps.

Step 1 - First, predictive equations are derived (regressed) which relate a set of explanatory variables to the probability that the average American will participate in the given activity. The dependent variable in this equation (one equation for each activity) is a 0-1 variable representing participation (1) or non-participation (0).[3] The explanatory variables are generally such things as: type of residence, travel distance (cost), age, years of education, race, length of work week, number of vacation days per year, family income, and sex. For extensive discussion on such determinants, see Jungst (1978) and King (1968).

Step 2 - Second, if the available data permits, predictive equations are derived (regressed) which relate a set of explanatory variables (often, but not always the same set as in Step 1) to the "amount" that a participant recreates in the given activity.[4] Obviously, this second set of equations is only regressed on participants in the given activity.

A very substantive problem exists in terms of measuring the intensity of consumption itself. Existing units of measure which are commonly used include: visitor days and number of trips. The first of these includes, indirectly, the frequency of participation as well as duration of participation over whatever time period (such as a year) employed. The second indicates only the frequency of participation, with no information included concerning the duration of any given trip. Even though the latter of these units of measure is the less informative, it is the one which is most easily and reliably employed in data collection, i.e., it is easier to determine number of trips than it is to determine duration of the trips.

Step 3 - Third, it is necessary to project the explanatory variables used in the equations derived in Steps 1 and 2. It should be noted that the regression equations are based on a random sample of the relevant population. Thus, ignoring any possible sampling or aggregation biases, the equations consist of average parameters which can be used with projections of explanatory variable averages (e.g., average age, average income, etc.) to project the average probability and intensity of participation. The average probability can also be interpreted as the expected percent of the population that will participate in the given activity.

Step 4 - Fourth, the regression equations and the independent variable projections are used to project participation. This is accomplished by substituting expected future independent variable values into the regression equation to arrive at the percent of the future population that is expected to participate in the given activities. Then, the number of participants is projected by applying these percents to the population projections. For ease of interpretation, indexes are also calculated. This can be accomplished by a computer program which allows sensitivity analysis on the scenarios and supply availability projections.

WEAKNESSES IN THE METHODOLOGY

Constancy of Relationships

As has been identified in a number of publications, the general projection approach suggested here relies on the assumption that the relationships identified by regression analysis remain constant in the future (throughout the projection period). This is obviously a heroic assumption. If several consistent cross-sectional surveys were available, some evaluation of this assumption (either qualitative or quantitative) might be possible by repeating the regression analysis on each survey's data set, and observing the trend in equation parameters.

Underspecification

The R-squares for regression equations in this type of analysis tend to be quite low. This would indicate that, in terms of explaining individual behavior, the regression equations are underspecified. It is possible that much of this unexplained variation in individual behavior will be essentially constant in the future, and thus the projections of aggregate behavior are valid. Nonetheless, this problem taken together with the assumed constancy of relationships indicates a potential for substantial variation in future recreation participation which is not explained by the participation equations. Furthermore, it is possible that this underspecification will bias the parameters in the participation equation on the variables that are specified (Kmenta 1971).

This is probably the most nagging problem in participation projection--we really do not know the determinants of recreation behavior. Again, social-psychological work such as that of Driver and Brown (1975) probably shows the greatest promise in improving our understanding of these determinants. Recent work by King (1980) should also suggest specification improvements.

Identification

The problem of identification in regressing participation equations such as those in this analysis has been discussed by a number of authors, most notably, Kalter and Gosse (1969, 1970), Knetsch (1969), and Cichetti (1973). These authors take the position that public recreation behaves within a "market" structure (in aggregate terms), where price does not appear in the supply function. Thus, no identification problem seems to exist, per se. The main issues which have been discussed, then, would seem to be specification questions--the proper way to account for variation in supply in the participation equation (1).

In terms of consumption (as opposed to quantity demanded), a simultaneous system might be operating since consumption is affected by availability of recreation resources, and public sector investment in recreation is indicated to be sensitive to levels of use. Thus, define:

$$Q_c = f(P, x_i, Q_p) \tag{1}$$

$$Q_p = g(Y_j, Q_c) \tag{2}$$

where: Q_c is quantity consumed

Q_p is quantity produced

P is price

X_i are demand shifters

Y_j are supply shifters

The reduced form equations for this system of equations are:

$$Q_c = f^*(P, x_i, Y_j) \tag{3}$$

$$Q_p = g^*(P, x_i, Y_j) \tag{4}$$

Thus, if Q_c is regressed against not only the arguments in (1), but also the supply shifters, Y_j, then Q_c can be consistently projected with (3). However, since equation (2) describes the behavior of a public body, identifying and measuring the Y_j may be extremely difficult. In order to regress a participation equation, we are left with only two choices:

1. Regress $Q_c = f(P, x_i, Q_p)$
   and risk a simultaneity bias, or
2. Regress $Q_c = f(P, x_i)$
   and risk an underspecification bias (having left out the Y_j).

The former course is suggested for three reasons:

1. The underspecification of these models is already so severe that further underspecification is unacceptable.
2. If, in the data set used, the supply of recreation resources is predominantly an independent variable (either in the private market, of by a public sector which is acting independently or with a time lag), then no simultaneity bias will be present, and
3. Q_p, or part of its, is the choice variable for the Forest Service in its allocation problem--the quantity of recreation resources to be produced. Thus, inclusion of this variable in the participation equations would seem to be very important as long as it significantly affects Q_c.

Aggregation Bias

Another potentially serious problem in the methodology employed is an aggregation bias in the participation equations. This problem arises because data from a cross-sectional survey describe individual behavior, whereas the identified relationships are used to project aggregated use levels subject to projections of aggregated explanatory variables.

For simplicity, consider only the relationship between recreation participation (P) and say, income (I). And, assume we have a set of micro-relationships:

$$P_j = a_j \cdot I_j + k_j \qquad J = 1, n \text{ individuals}$$

The correct aggregation of these micro-relationships to yield an average participation rate would be:

$$\frac{\sum_{j=1}^{n} P_j}{n} = \frac{\sum_{j=1}^{n} (a_j \cdot I_j)}{n} + \frac{\sum_{j=1}^{n} k_j}{n} \qquad (5)$$

However, if regression analysis is performed on cross-sectional data, and this equation is combined with a projection of average income, then the projected average participations rate would be:

$$\frac{\sum_{j=1}^{n} P_j}{n} = \frac{\sum_{j=1}^{n} a_j}{n} \cdot \frac{\sum_{j=1}^{n} I_j}{n} + \frac{\sum_{j=1}^{n} k_j}{n} \qquad (6)$$

Which is equivalent to (5) only if all a_j are equal to ($\bar{a}_j$). In other words, if regression analysis is performed on cross-sectional survey data to estimate the relationships between participation and some given explanatory variables, these relationships can only be used to project aggregate use with an assumption of homogeneous population behavior characteristics.

This bias in projected participation could theoretically be removed if average per capita income ($\bar{I}_j$) is a weighted average (weighted by $\frac{a_j}{\bar{a}_j}$) (Hof 1979). Determination of these individual a_j's does not seem practical. This weighting structure does clearly indicate, however, that the magnitude of the bias is determined by the degree to which the micro-parameters (a_j's) vary across different individuals. Obviously, the better the participation equations are specified, the more likely homogenous micro-parameters are. Thus, improved specification will certainly ameliorate this problem of aggregation.

The only way to directly avoid this problem would be to study aggregated behavior instead of individual behavior in the regression analysis. In terms of investigating the causal factors of recreation participation, this approach would be disadvantageous because the aggregation of behavioral indicators might obscure many of the relationships to be investigated. And, without combined cross-sectional and time-series data, no estimate can be made of the variability in micro-parameters between individuals which causes the aggregation bias in the first place.

Heteroskedasticity

Goldberger (1964) demonstrated that ordinary least-squares (OLS) estimation with a dichotomous dependent variable will have heteroskedastic residuals--the variance of the residuals will vary systematically with the independent variables. This conditions makes the OLS estimation procedure inefficient. It is noted that these inefficient estimators will be unbiased in large sample sizes, since they do have the proper asymptotic properties (Goldberger 1964; Kmenta 1971; Johnston 1972). It is this property which is probably responsible for the common use of OLS in this type of analysis, despite the inefficiency. Some question does seem to remain, however, concerning estimated variances of the estimated coefficients and thus the reliability of statistical significance tests. Assume a model:

$$\underset{(n \times 1)}{y} = \underset{(n \times k)}{X}\ \underset{(k \times 1)}{B} + \underset{(n \times 1)}{E},$$

and define b as the OLS estimator of the slope coefficient for a given x. Kmenta (1971:256) derives an expression for the bias on the estimated variance of b--$\hat{V}(b)$-- in a simple linear model with possibly non-zero intercept and concludes that if:

$$\sigma_i^2 = a_0 + a_1 x_i^2, \qquad (14)$$

then the sign of the bias of $\hat{V}(b)$ depends on the sign of a_1. For example, if σ_i^2 and x_i^2 are negatively associated, then $B(\hat{V}(b))$ is positive, significance tests are conservative, and confidence intervals are wider than the correct ones for b (so the estimator is more precise than indicated).

If we assume Goldberger's error structure and consider the special case where $\beta \bar{x} = 1/2$, then

$$\sigma_i^2 = 1/4 - \beta^2 x_i^2,$$

which is (14) with the sign of a_1 negative. Thus, inferences from OLS concerning β when the dependent variable is dichotomous are tenable (in fact, conservative) if the mean of the βx_i is 1/2. And, it seems likely that this desirable characteristic would apply to cases where βx_i is close to 1/2 as well. The latter includes the important cases where one attempts, by design, to sample uniformly over the feasible x_i in the model, or otherwise symmetrically over the entire feasible range of the x_i. The extension of this conclusion to the multivariate case is not straightforward. This analysis at least demonstrates, however, that tenable statistical inferences are possible with a dichotomous dependent variable.

It is thus recommended that the more exotic alteratives to OLS be employed whenever small sample sizes are encountered. And, it is suggested that OLS will not be totally unacceptable with the large sample sizes that make these exotic methods impractical.

All of this presupposes, of course, that the zero-one dependent variable structure is used. A heteroskedasticity problem is hard to avoid, however, because in a National sample, we can generally expect a large cluster of zero responses.

VALUATION OF OUTDOOR RECREATION

Early economic thought on value centered on such positions as those of the Merchantilists and Physiocrats. The Merchantilists contended that social value was derived from a good's ability to bring wealth (generally measured in gold) into a society through international trade. The Physiocrates, in contrast, felt that value was derived from nature--that is, that the value of a good was equal to its physical production requirements. An extension of this position was provided by Adam Smith in his "Labor Command" theory of value. Smith postulated that the value of a good is determined by the labor "conjealed" within it--the total human production requirement. By the late nineteenth century, however, these production-oriented theories of value were losing favor. In their place, through the work of economists such as Menger, Jevons, and Walras, the criteria of subjective consumer satisfaction (utility) was becoming widely accepted. Through the work of many economists--for example, Marshall and Pigou--a great deal of economic theory has been developed under the basic theorem that marginal utility is indexed by the marginal price that an individual is willing to pay for any given level of consumption. (Blaug 1962; Worland 1967; Graaff 1971; Henderson and Quandt 1971).

It is with this theorem that most valuations are accomplished today. A good is "worth" its price in the market system. In evaluating public forest resources, however, the problem is not quite so simple. For those forest products (such as timber stumpage) that are "sold" in a bidding process, at least some type of market system has been applied. For non-market products (such as public recreation resources), no market system has been applied at all, and thus no price has been applied. The problem, therefore, is to determine some method of evaluating recreation resources that is consistent with the evaluation that would be obtained in a market system. Again, a market price is considered a measure of value only because it reflects marginal consumer willingness-to-pay.

The utility maximization apparatus employed in the derivation of a Marshallian demand curve indicates that, for an individual consumer, prices monotonically index his marginal utility (for that level of consumption which he chooses). In order to arrive at a community, or aggregate set of value indexes, this paper will assume the Paretian approach to be acceptable. This approach accepts the present distribution of income, and uses this distribution of income as an aggregation scheme--the aggregate demand curve for a community with a given income structure is merely the horizontal summation of individual demand curves. Market equilibrium prices are determined on the basis of this income-weighted aggregate demand curve, and the imposed aggregate supply curve.

A number of methods have been employed to attempt the evaluation of recreation resources and experiences. These will be briefly reviewed before proceeding. More detailed reviews and comparisons of these methods are available in the literature (Knetsh 1974; O'Connell 1977; Knetsch and Davis 1972; Dwyer, Kelly, and Bowes 1977; Beardsley, 1971).

COMMON METHODS OF VALUATING RECREATION

The vast majority of attempts made at evaluating recreation fall into one of the five basic approaches discussed below.

1. Production Costs. This method estimates a good's value by totaling the production costs involved. This is basically a return to the position of the Physiocrats--a position which has been rejected by mainstream economics for nearly 200 years. This approach gives no importance whatsoever to the consumer's evaluation or willingness-to-pay for the good. It should also be noted that this approach will always guarantee a benefit-cost ratio of one. Since production costs are always equal to themselves, the approach will always indicate economic justification for any good's production at any level.

2. Opportunity Costs. This method is quite similar to the Production Costs approach. In this case, the value of a good is considered equal to the value of goods that are foregone in order to produce it. This approach may be slightly more tenable, and can possible generated a benefit-cost ratio other than one.[1] However, the value of the good is still determined by its production characteristics rather than the consumer's subjective evaluation. This index would be quite different than one measuring the consumer's direct willingness-to-pay for the good, independent of that good's production.

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[1]In equilibrium, however, the opportunity cost is actually equal to the production cost, and will thus yield a benefit-cost ratio of one, if used as a benefit measure.

3. Unit Day Values. This approach calculates a constant value index on the basis of resource (site) charateristics. The exact origin of these value indexes is not clear, but they may be at least partially based on willingness-to-pay. It is not clear that the unit day values commonly used by public agencies are analytically determined as opposed to politically negotiated. Furthermore, the technique implicitly assumes a horizontal demand curve. This is a questionable assumption that could seriously bias valuation results. If, for example, recreation experiences are subject to diminishing returns, and recreation experiences were already provided to the point of near-zero marginal value, the Unit Day Value approach could still justify further recreational development.

4. Travel Costs. This approach applies the marginal expenditure, travel costs, on recreation experiences as the marginal value of the experience. This approach is the only one thus far discussed which has strong theoretical foundation, being based on willingness-to-pay. The primary criticism is that travel costs are only part of the marginal expenditure for recreation experiences. That is, travel costs are not the full price felt by the consumer for his experience. Also, the method of deriving value indexes for the recreation resource from those for the experience is not clear. These points will be discussed at length below.

5. Inteview Methods/Bidding Games. Finally, attempts have been made to elicit recreation value indexes using interviews and/or bidding games. In simplest terms, these methods use surveys or interviews to ask a sample of the relevant population what the recreation experience or resource is worth to them.

Because this method creates a hypothetical situation, it can be designed to attempt measurement of whatever variables desired--as opposed to the travel cost method which relies on measuring variables occurring "naturally" in society. It is this very hypothetical nature of the method, however, which raises questions concerning its reliability.

Nonetheless, this approach and the travel cost approach are the only ones discussed which can be, with proper design and execution, logically tenable and theoretically correct. In the case that market prices are available for the sort of recreation to be evaluated, these data would certainly be most desirable for demand analysis and benefit estimation. The remainder of this section will focus on the more difficult case where no market data are available.

THE TRAVEL COST APPROACH

The Traditional Travel Cost Model--A Household Production Framework

The early presentations (HCK)[2] of the travel cost model employed a conceptual specification of recreation commodities in something of a Household Production Function framework where:

$E = F(R, T, X)$

E = Recreation Experiences

R = Recreation Resources

T = Travel

X = Other factors of production not considered

f = A Household Production Function

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[2]Hotelling (1949), Clawson (1959), Clawson and Knetsch (1966).

That is, the consumer was assumed to be producing recreation experiences from a variety of production factors--especially travel and the recreation resource. Since the resource is generally priced at or near zero, the cost of travel was logically indicated to be the cost of the experience (so long as no other costs of producing experiences were important). Thus, observing individuals' recreation trip-taking behavior who face different travel cost is taken as a reasonable approach in deriving a demand curve for recreation experiences, given the assumptions discussed in the classic literature.

The HCK approach did not stop here, however. This demand curve for the experience will be referred to as the "first stage" model. HCK also present a "second stage" model which they discuss as a derived demand curve for the recreation resource--"derived" apparently in the sense that it is a demand curve for a factor of production that is derived from the demand curve for the final product.

Though recent literature seems to often avoid labelling the second stage model as a "derived demand curve" (an important exception is Cicchetti, Fisher, and Smith 1976) it is still often presented as a demand curve for the "site," or "recreation resource."[3]

The basic assumption which allows the interpretation of the second stage model as a demand curve for the recreation resource is:

> increase in park price is viewed no differently by the consumers than an increase in travel cost." (Cesario and Knetsch, 1976, p. 99)

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[3]See, for example, Cesario and Knetsch (1976), and Dwyer, Kelley, and Bowes (1977).

The "reaction" which the second stage model observes is actually a change not only in the consumption of the resource, but also a change in the consumption of travel. In other words, all that has been measured is a change in the consumption of experiences--including both travel and resource input utilization. A change in resource consumption associated with a resource price change as never been isolated. Likewise, the aglomeration of travel costs and resource costs into "costs" indicates that the analysis has never observed anything but experience consumption. All of this is also evidenced by the fact that the second stage model is generally in the same units as the first stage model--for example, number of visits and price of a visit (or more precisely, a given change in the price of a visit).

Furthermore, in the Household Production Function framework the value of the recreation resource is generated by its capability to produce the utility-providing final good, the recreation experience. Economic theory indicates this conclusion by stating that the efficient, equilibrium price of any factor is its value-marginal-product--the marginal physical product of a factor X in producing good Y times the equilibrium price of that good Y (Henderson and Quandt 1971). In other words, the correct value index for the recreation resource should be derived by multiplying the experience value index by the marginal product of the resource in producing that experience. The second stage HCK model would only be consistent with derived demand theory if the observed consumers are behaving in their consumption decisions according to this condition.

Some questions must be raised as to whether this marginal product exists for the recreation experience Household Production Function. It appears that for a given individual with a fixed origin, a certain mix of inputs (travel and recreation resources) is absolutely necessary for any given experience(s), and that no trade-off between these factors is possible. This would indicate that no true isoquant exists (it is a single point) and therefore the marginal product is undefined at the relevant point of analysis. If this is the case, then the consumer will only be able to consume one quantity of the resource, for any given quantity of experiences--the consumer will generally be unable to behave according to the value-marginal-product condition for derived demand. Interestingly, this logic indicates that even if a public recreation site was "priced" with an entry fee the resource would still be inseparable from the experience.

If an isoquant and marginal products do exist for the production of experiences, the travel cost model may still be incapable of deriving a demand curve for the resource, per se. Assume that the recreation resource to be evaluated has no directly attached price (such are the conditions which necessitate an evaluation analysis). Also, assume the P_E is an equilibrium price of the experience, at the equilibrium level of consumption E. The rational consumer/producer will then minimize the cost of production of E.

Assume two factors of production:

R = recreation resource

T = travel

and a household production function:

$E = f(R,T)$.

And, minimize:

$$C = P_R \cdot R + P_T \cdot T$$

Subject to:

$$E \leq F(R, T)$$

Where:

C = cost of production of experiences

P_R, P_T = prices of the recreation resource and travel, respectively

E = number of experiences.

Forming the Lagrangean:

$$L = P_R \cdot R + P_T \cdot T + \lambda \cdot [E - f(R, T)]$$

And, deriving first-order conditions:

$$\frac{\partial L}{\partial R} = P_R - \lambda \frac{\partial f}{\partial R} \overset{\text{set}}{=} 0$$

$$\frac{\partial L}{\partial R} = P_T - \lambda \frac{\partial f}{\partial T} \overset{\text{set}}{=} 0$$

$\frac{\partial L}{\partial \lambda} \overset{\text{set}}{=} 0$, the constraint is binding.

and, $\frac{\partial L}{\partial E} = \lambda$, marginal cost of E.

Thus, one first order condition is:

$$P_R = \lambda \frac{\partial f}{\partial R} = \text{the marginal cost of the marginal experience} \cdot \text{marginal product of the resource}$$

(This is analagous to value-marginal-product pricing in the theory of the firm.)

But:

$P_R = 0$ (the resource is "free").[4]

Therefore, the consumer will utilize R until its marginal product is 0.

This indicates that if the recreation resource is zero-priced and an isoquant exists between travel and the resource, then the consumer would operate accordingly at the resource-axis intercept of that isoquant. This will be true regardless of the cost of the other factor, travel, so long as it is non-zero. Therefore, in this case, the cost of travel has nothing to do with the consumption of the resource except that the equilibrium quantity of experiences demanded (E) is affected by travel costs. Just as before, travel costs can only be related to the consumption of experiences, not to the consumption of the resource. The first point calculated in the HCK second stage model is the horizontal intercept of the resource "derived demand curve," corresponding to the resource axis intercept of the isoquant. But at no time, theoretically, can we observe the consumer when his marginal product of the resource in producing the experience is anything but 0.

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[4]It is possible that the consumption of R will be restricted by limited resource capacity. In this case, the condition that $P_R = \lambda \cdot \frac{\partial f}{\partial R}$ does not hold. That is, consumption of R is determined not by efficiency criteria, but rather, an exogenous constraint. Thus, the $\frac{\partial f}{\partial R}$ at that point Would not be the correct one, and the derived P_R would reflect the limited quantity of R, and not the value of R in producing E.

It is concluded, therefore, that travel costs cannot be employed to identify a derived demand curve for the recreation resource, per se. The cost of travel is the (transaction cost) price of the experience commodity and changes in the quantity of travel and resource inputs utilized cannot be isolated.[5]

In sum, if a Household Production Function is used to relate travel and site inputs to the production of experiences, then:

1. If the site and travel input requirements for a given number of experiences are fixed, the isoquant between travel and site inputs is a single point, the marginal products are undefined, and a "derived demand" for the site cannot be calculated.
2. If an isoquant exists, the only observable point will be the site-input axis intercept, due to the zero site price.
3. In either case, the utilization of the site input cannot be isolated from the utilization of travel, and all observations actually involve experience consumption.

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[5]Freeman (1979) presents an interesting discussion concerning shifts in demand for private commodities resulting from qualitative environmental improvements. If a proposed site is perceived as a qualitative improvement resulting in a shift in the demand curve for the experience (given a fixed travel input) then a site's value may be isolable. It seems more reasonable, however, that the construction of a new site causes a price (travel cost) reduction and a shift along a fixed experience demand curve.

Travel Cost Model in a Community Production Framework

In contrast to the case of a Household Production Function discussed above, a public agency (community) can be regarded as an "experience producer" that can trade-off travel for resource inputs to production, and that faces a non-zero resource price. The more recreation sites that are available to a community, the less community travel is necessary for a given number of recreation experiences to be produced. Thus, implicitly, a public land agency is allocating community travel and recreation resources given the aggregate demand curve for the recreation experience based on individual willingnesses-to-pay.

If, in a given instance, the travel input to a community's recreation could be considered "correct" (efficient), then the value marginal-product of a proposed recreation site might be regarded as the value of additional community recreation experiences which the site could provide, given that fixed amount of travel.

Pragmatically, the "present" amount of recreation travel could rarely be regarded as being "correct," and thus a new site creates both an increase in the number of experiences and a cost savings by allowing a different mix of travel and resource inputs. This suggests the logic presented and applied by Burt and Brewer (1971). They develop a benefit measure from the experience "price" changes which occur with the construction of a proposed site (or the removal of an existing site). That is,

> "Development of the site will change the minimum distance (price) that some of the population must travel (pay) in order to consume services from the category of sites in which the development fits. Thus, an investment in outdoor recreation will change the price vector faced by at least some of the population." (Burt and Brewer, p. 815).

Thus, the value of an additional site is the change in total net value of experiences it creates through a price change. This total net value change includes: an increase in gross benefits (willingness to pay); a travel cost change; and the additional variable costs of operating the new recreation site and amortized cost of the investment itself.[6]

The change in gross benefits less travel costs is equivalent to the change in consumers surplus caused by the price shift (the area to the left of the experience demand curve, between the two price horizontals). This welfare measure involves changes along the demand curve for the experience, and the demand for the resource is never considered in the analysis, per se. In fact, this "experience" is defined as a fixed composite of travel time and the site experience. As Burt and Brewer state:

> "...travel time and the recreation experience itself are a package of commodities in the usual economic sense, and the consumer has no alternative to the particular package presented to him by his spatial location. The situation is analogous to a consumer being refused a price quotation on a commodity that he wishes to purchase, but instead, he is quoted a price per unit of that commodity taken with so many units of another commodity... As long as purchases have to be made in this fixed proportion, all value inferences can be made from the aggregate commodity." (Burt and Brewer 1971, p. 826).

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[6]It is theoretically undesirable to intermingle production cost efficiency and benefit estimation in this manner; however, in an applied context, there seems to be little alternative at this time.

Thus, the value of the proposed site is not determined by its own demand curve, but rather by the price-change-induced increase in net benefits created by the consumption of the composite commodity. Burt and Brewer demonstrate that this indicator is actually equivalent to the entire area under the HCK second stage curve in the case of only one site.[7] They demonstrate that the area under the HCK second stage curve is acually a horizonal summation of first stage experience demand consumers surpluses of each individual, with the travel cost for each acting as the surrogate price line above which the surplus is calculated. Therefore, the benefit estimates derived from the HCK second stage demand curve are not erroneous, they have merely been misinterpreted. This is important because as long as the second stage model is misinterpreted as a derived demand curve, the inappropriate commodity definitions are likely to be employed. That is, if we presume that our demand analysis is based on the site, then site characteristics will define the commodity set. If, however, site use cannot be meaningfully isolated from the composite experience commodity, then experience characteristics should be used to define the commodity set. A demand curve will thus apply to a particular type of experience rather than a type of resource. Furthermore, in an aggregate demand curve, the experience "type" must be constant over all consumers rather than resource "type."

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[7]This implies a price change from infinity to the travel cost (price) of the one site. If the HCK approach is used when this is not the case, a significant over-estimate of benefits is possible.

THE BIDDING GAME APPROACH

Davis (1963) can probably be credited with the earliest development of this method as applied to recreation. Other important efforts include: Randall, Ives and Eastman (1974); Horvath (1974); Hammock and Brown (1974); Walsh, Ericson, McKean, and Young (1978); and Brookshire, Ives, and Schulze (1976). These works provide good descriptions of the approach. Dwyer, Kelly and Bowes (1977) and Brookshire and Crocker (1978) also provide excellent discussions and analysis of the methodology. Only a few additional remarks will be made here.

The principal advantage with an interview or bidding game (BG) approach is that the researcher is no longer obliged to measure phenomena that occur naturally in the real world. The BG, rather, is hypothetically constructed, and can therefore create whatever hypothetical situation desired. Thus, a BG can be designed to elicit a consumer's willingness-to-pay for the recreation resource directly. Further, the BG can be designed to attempt measurement of the complete price of the experience or resource,[8] since it is not limited to travel costs in its hypothetical market situation. And finally, a bidding game can possibly identify more than one point on each individual's demand curve, and thus allow for the theoretically correct horizontal summation of these individual demand curves into the aggregate demand curve.

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[8]It is possible that travel and resource consumption would still be inseparable even in a hypothetical market situation, and that the composite, experience is still the only acceptable commodity for demand analysis.

The questions which arise concerning the potential of bidding games, however, do so as a direct result of this same hypothetical construction. The main question is: Will a respondent in a bidding game give responses which are equivalent to what his actions would have been had the game situation been real, rather than hypothetical?

Many authors[9] have discussed the potential of gaming strategies biasing the results of a BG. As Dwyer, Kelley, and Bowed (1977) summarize:

> The survey method is predicted on two key assumptions: (1) that consumers can assign an accurate value to the recreation experience, and (2) that this valuation can be elicited from them with a properly constructed question or series of questions. The recreation survey literature has not given a great deal of attention to the first assumption. . . . This second assumption has generated considerable debate. (p. 57)

Another reason that individuals who can express their valuations accurately in the market system, but may not be able to in a bidding game, is that an element of uncertainty is introduced by the artificial setting of a bidding game. The formulations below summarize the effects of strategy and uncertainty in a BG, and provide some interesting conclusions concerning the type of game most likely to provide unbiased responses.

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[9]See, for example, Samuelson (1954), and Brookshire and Crocker (1978) as well as the bidding game studies previously cited.

Assume the following bidding game:

Responses

x_1 = consumption (# visits/year, for example) of a given site

x_2 = consumption of some other good (e.g., some timber product).

Given

Px_1, Px_2 = a set of prices given in the game for x_1 and x_2 respectively.

(This is the structure most like a market framework.)

That is, each respondent will be given a set of prices (Px_1 and Px_2) and will be asked to give some kind of indication as to his resultant level of consumption of the associated goods (x_1 and x_2). Individual or aggregate demand curves could hypothetically be derived from these responses.

Now, assume that the following are perceived by the respondent.

Pc_1 = probability that Px_1 will actually be charged. If the respondent believes that his response affects Pc_1, then:

$$Pc_1 = g_1(x_1)$$

Pc_2 = a similar probability for Px_2 and x_2, and:

$$Pc_2 = g_2(x_2)$$

Pp_1 = probability that the given site will be provided. If the respondent believes that his response affects Pp_1, then:

$$Pp_1 = f_1(x_1)$$

Pp_2 = a similar probability for x_2 and Pp_2, and:

$$Pp_2 = f_2(x_2).$$

Then, the rational respondent will try to maximize his expected utility, subject to his expected budget constraint.

Maximize:

$$E(U) = f_1(x_1) \cdot U(x_1) + f_2(x_2) \cdot U(x_2).$$

Subject to:

$$g_1(x_1) \cdot Px_1 \cdot x_1 + g_2(x_2) \cdot Px_2 \cdot x_2 \leq I.$$

Forming the Lagrangean:

$$L = f_1(x_1) \cdot U(x_1) + f_2(x_2) \cdot U(x_2)$$
$$+ \lambda [I - g_1(x_1) Px_1 x_1 - g_2(x_2) \cdot Px_2 \cdot x_2].$$

Deriving first-order conditions:

$$\frac{\partial L}{\partial x_1} = \frac{\partial f_1}{\partial x_1} U(x_1) + \frac{\partial U}{\partial x_1} f_1(x_1) - \lambda \left[\frac{\partial g_1}{\partial x_1} Px_1 x_1 + Px_1 g_1(x_1) \right]$$

$$\text{set} = 0$$

$$\frac{\partial L}{\partial x_2} = \frac{\partial f_2}{\partial x_2} U(x_2) + \frac{\partial U}{\partial x_2} f_2(x_2) - \lambda \left[\frac{\partial g_2}{\partial x_2} Px_2 x_2 + Px_2 g_2(x_2) \right]$$

$$\text{set} = 0$$

$\frac{\partial L}{\partial \lambda} = 0$, constraint is binding.

Therefore:

$$\frac{\frac{\partial f}{\partial x_1} \cdot U(x_1) + \frac{\partial U}{\partial x_1} f_1(x_1)}{\frac{\partial f_2}{\partial x_2} \quad U(x_2) + \frac{\partial U}{\partial x_2} f_2(x_2)} = \frac{g_1(x_1) \quad Px_1 + \frac{\partial g_1}{\partial x_1} Px_1 x_1}{g_2(x_2) \quad Px_2 + \frac{\partial g_2}{\partial x_2} Px_2 x_2} .$$

In general, the only way that this conclusion indicates that:

$$\frac{Px_1}{Px_2} = \frac{\frac{\partial U}{\partial x_1}}{\frac{\partial U}{\partial x_2}} \qquad \text{(the desired result)}$$

is if:

$$(1) \quad \frac{\partial f_1}{\partial x_1} = \frac{\partial f_2}{\partial x_2} = \frac{\partial g_1}{\partial x_1} = \frac{\partial g_2}{\partial x_2} = 0$$

and,

$$(2) \quad f_1(x_1) = f_2(x_2) \text{ and } g_1(x_1) = g_2(x_2)$$

(1) would only be true if the respondent's reactions are based on his belief that his response does not affect the probabilities of either charge or provision. (Thus, no strategy exists.)

(2) would only be true if:

(a) no uncertainty exists, such that:

$$f_1(x_1) = f_2(x_2) = g_1(x_1) = g_2(x_2) = 1$$

or,

(b) the uncertainty perceived by the respondent happens to be the same for all goods involved.

In order to examine the potential biases, let us assume that x_2 is a market good, such as a timber resource/product. Thus x_2 will be perceived to behave like a typical market good, and:

$$f_2(x_2) = 1$$

$$g_2(x_2) = 1.$$

Then, the firest order condition becomes:

$$\frac{\frac{\partial f_1}{\partial x_1} U(x_1) + \frac{\partial U}{\partial x_1} f_1(x_1)}{\frac{\partial U}{\partial x_2}} = \frac{g_1(x_1)\ 0x_1 + \frac{\partial g_1}{\partial x_1} Px_1\ x_1}{Px_2}$$

The biases created by different assumptions about the BG respondent's game strategies and perceived uncertainties can not be analyzed. Specifically, the following different assumptions affecting either f_1 or g_1 can be made:

	Assumption:	Implying that:
I.	no uncertainty and no strategy	$f_1(x_1) = 1$
		$\frac{\partial f_1}{\partial x_1} = 0$
		$g_1(x_1) = 1$
		$\frac{\partial g_1}{\partial x_1} = 0$
II.	uncertainty exists, but with	$0 < f_1 < 1$
	no gaming strategy	$\frac{\partial f_1}{\partial x_1} = 0$
		$0 < g_1 < 1$
		$\frac{\partial g_1}{\partial x_1} = 0$
III.	uncertainty exists, along with	$0 < f_1 < 1$
	a rational gaming strategy	$\frac{\partial f_1}{\partial x_1} > 0$
		$0 < g_1 < 1$
		$\frac{\partial g_1}{\partial x_1} > 0$

Thus, three different assumptions can be made on f_1 and g_1 which will describe the possible gaming strategies and perceived uncertainties. It should be noted that the possibility of a strategy existing in the absence of uncertainty cannot be examined with the formulations presented here, because strategies are expressed in terms of affecting the probabilities of site provision and fee imposition. It is true that a respondent might have a strategy of influencing the level of the fee charged rather than the probability of the fee being charged. The analysis would, in substance, be altered little since in both cases, a strategy is assumed where the expected value of the site fee is affected positively by the response, x_1. It makes little difference to this analysis whether the expected fee is influenced through the magnitude of the fee itself, or the probability of it actually being charged. Since prices are given in this bidding game, the approach taken seems the most reasonable. And, the case of a strategy being present in the absence of uncertainty is not the focal point of this discussion.

The biases resulting from these different behavioral assumptions are created in the first order condition by the presence of the following terms:

1. in the numerator on the left hand side of the condition:

   the $\frac{\partial f_1}{\partial x_1}$ term, and

   the $\frac{\partial U}{\partial x_1} f_1(x_1)$ term.

2. in the numerator on the right hand side of the condition:

   the "$g_1(x_1)$" term, and

   the $\frac{\partial g_1}{\partial x_1} Px_1 x_1$ term.

Figure 1 summarizes the nine possible combinations of assumptions on f_1 and g_1, and presents the expected bias on the respondent's indication of x_1 under those different assumptions. The first order conditions associated with each cell in Figure 1 are as follows:

Cell	First Order Condition
1,1	$\frac{\frac{\partial U}{\partial x_1}}{\frac{\partial U}{\partial x_2}} = \frac{Px_1}{Px_2}$
1,2	$\frac{\frac{\partial U}{\partial x_1} f_1}{\frac{\partial U}{\partial x_2}} = \frac{Px_1}{Px_2}$
2,1	$\frac{\frac{\partial U}{\partial x_1}}{\frac{\partial U}{\partial x_2}} = \frac{g_1 Px_1}{Px_2}$
2,2	$\frac{\frac{\partial U}{\partial x_1} f_1}{\frac{\partial U}{\partial x_2}} = \frac{g_1 Px_1}{Px_2}$
1,3	$\frac{\frac{\partial f_1}{\partial x_1} U(x_1) + \frac{\partial U}{\partial x_1} f_1(x_1)}{\frac{\partial U}{\partial x_2}} = \frac{Px_1}{Px_2}$
2,3	$\frac{\frac{\partial f_1}{\partial x_1} U(x_1) + \frac{\partial U}{\partial x_1} f_1(x_1)}{\frac{\partial U}{\partial x_2}} \quad \frac{g_1 Px_1}{Px_2}$
3,1	$\frac{\frac{\partial U}{\partial x_1}}{\frac{\partial U}{\partial x_2}} = \frac{g_1(x_1) Px_1 + \frac{\partial g_1}{\partial x_1} Px_1 x_1}{Px_2}$

$$3,2 \qquad \frac{f_1 \frac{\partial U}{\partial x_1}}{\frac{\partial U}{\partial x_2}} = \frac{g_1(x_1)\ Px_1 + \frac{\partial g_1}{\partial x_1} Px_1\ x_1}{Px_2}$$

$$3,3 \qquad \frac{\frac{\partial f_1}{\partial x_1} U(x_1) + \frac{\partial U}{\partial x_1} f_1(x_1)}{\frac{\partial U}{\partial x_2}} = \frac{g_1(x_1)\ Px_1 + \frac{\partial g_1}{\partial x_1} Px_1\ x_1}{Px_2}$$

Given a second order condition of diminishing marginal utility, deduction of the bias created by these conditions on the x_1 which would have been indicated if:

$$\frac{\frac{\partial U}{\partial x_1}}{\frac{\partial U}{\partial x_2}} = \frac{Px_1}{Px_2}$$

is straight forward. For more discussion, see Hof (1979).

For cell (1,1), in the absence of either uncertainty or gaming strategy, the results are indicated to be unbiased. For the cells (1,2), (2,1), and (2,2), the assumption that:

$$0 < g_1 < 1$$

$$0 < f_1 < 1$$

indicates that an upward bias on x_1 is created by the uncertainty of fee imposition, and a downward bias on x_1 is created by the uncertainty of site provision. This is the case because the uncertainty of fee imposition has the affect of relaxing the expected budget constraint, and the uncertainty of the opportunity to actually "consume" the site reduces its expected marginal utility.

Figure 1.--Biases on a bidding game respondent's responses created by different assumptions on his strategy and uncertainty.

Nature of $g_1(x_1)$ (probability of fee imposition) / Nature of $f_1(x_1)$ (probability of site provision)	$f_1 = 1$, $\frac{\partial f_1}{\partial x_1} = 0$ — no uncertainty no strategy	$\frac{\partial f_1}{\partial x_1} = 0$, $0 < f_1 < 1$ — uncertainty no strategy	$\frac{\partial f_1}{\partial x_1} > 0$, $0 < f_1 < 1$ — uncertainty + strategy
$g_1 = 1$, $\frac{\partial g_1}{\partial x_1} = 0$ — no uncertainty no strategy	(1,1) x_1 UNBIASED	(1,2) DOWNWARD BIAS on x_1	(1,3) Indeterminate
$\frac{\partial g_1}{\partial x_1} = 0$, $0 < g_1 < 1$ — uncertainty no strategy	(2,1) UPWARD BIAS on x_1	(2,2) Indeterminate	(2,3) Indeterminate
$\frac{\partial g_1}{\partial x_1} > 0$, $0 < g_1 < 1$ — uncertainty + strategy	(3,1) Indeterminate	(3,2) Indeterminate	(3,3) Indeterminate

In cell (2,2), since both biases are indicated, the overall bias is indeterminant.

For the remaining cells, the following information can be similarly deduced.

Since $0 < f_1 < 1$ in cells (1,3), 2,3), (3,2), (3,3),

$$f_1 \frac{\partial U}{\partial x_1} < \frac{\partial U}{\partial x_1} .$$

This will create a downward bias on x_1, and is the result of the uncertainty of site provision.

Since $\frac{\partial f_1}{\partial x_1} > 0$ in cells (1,3), 2,3), (3,3),

$$\frac{\partial f_1}{\partial x_1} U(x_1) > 0.$$

This will create an upward bias on x_1, and is the result of a gaming strategy to increase the probability of site provision.

Since $0 < g_1 < 1$ in cells (2,3), (3,1), (3,2), (3,3),

$$g_1 \, Px_1 < Px_1.$$

This will create an upward bias on x_1, and is the result of the uncertainty of fee imposition.

Since $\frac{\partial g_1}{\partial x_1} > 0$ in cells (3,1), (3,2), (3,3),

$$\frac{\partial g_1}{\partial x_1} Px_1 \, x_1 > 0.$$

This will create a downward bias on x_1, and is the result of a gaming strategy to decrease the probability of fee imposition.

It is clear from this information that cells (1,3), (2,3), (3,1), (,2), and (3,3) are all indicated to have both upward and downward biases on x_1, thus the overall bias is indeterminant.

The following conclusions can be drawn from the results of this analysis:

1. Unbiased responses will only be encountered in the absence of both strategies and uncertainty.
2. Removal of gaming strategies is not sufficient for unbiased responses. Uncertainty must also be removed.
3. Uncertainty concerning fee imposition biases the estimated demand curve upward and to the right.
4. Uncertainty about site provision biases the estimated demand curve downward and to the left.
5. A strategy to discourage fee imposition biases the estimated demand curve downward and to the left.
6. A strategy to encourage provision of a site biases the estimated demand curve upward and to the right.
7. The type of game which will be most likely to generate unbiased responses, is one which not only convinces the respondent that his strategies will not work, but also elicits responses which represent the respondent's expected actions given the actual existence of the site and the actual imposition of the site fee. Both gaming strategies and uncertainty might be minimized if the respondent is convinced that the "hypothetical" fee really is going to be imposed and that the site is either already available, or is definitely going to be made available in the future, at that price.

ANALYSIS OF RECREATION SUPPLY

As suggested in the introduction, two different types of supply analyses are required by the RPA: (1) inventory of existing opportunities and (2) marginal cost schedules or "economic supply schedules." Both of these categories of recreation supply analysis are reviewed below within the context of the analysis requirements of the RPA process.

In general, recreation inventory or "supply" studies have been attempts to describe the number of sites or the number of opportunities to participate. The approaches of four different agencies to "recreation inventory" are discussed below. It should be kept in mind that the purpose of these systems is to describe the "gap" between forecasted consumption or use and the level of opportunity that is or will be available. These systems are not meant to address the questions of economic supply. In constrast to recreation inventory systems, economic supply studies of recreation should describe the relationship between the level of recreation output and the costs of producing the outputs. Specifically, the relationship between incremental outputs and incremental costs should result from the analysis.

Traditional microeconomic models assume differentiable production functions and thus differentiable cost functions. In most cases, available or obtainable data do not permit estimation of these functions for forest outputs such as recreation, timber, wildlife, etc. As a result, studies have relied on operations research techniques to approximate production function. In the following discussion, inventory procedures and the experience of several agencies with them are reviewed. Following this, a discussion of production and cost analysis within the structure of linear programing is presented as the "state-of-the-art" in economic analysis of recreation supply.

INVENTORY PROCEDURES

Recreation Inventory in the National Parks

The National Park Service publishes a statistical report each year summarizing recreation use information in the National Parks. This information is collected through sales of passes and permits, registrations at trail heads, car counters, and other information collected by on-the-ground managers of each site. It reflects numbers of visitors to the different sites, the seasons of use, and sometimes background information about the visitor himself, such as state of residence, length of visit, and destination.

The National Park Service also publishes a Complete Guide to the National Parks, which is a comprehensive inventory of the recreation opportunities available in and around each of the National Parks. The Guide was last published in 1978, another Guide will be put out this year.

A survey of all the National Parks in the United States is conducted first. Information from each park is compiled and sent to that park for additions and corrections. When the Guide is complete it contains information about the attractions found in each park as well as in the surrounding areas. Descriptions of public access and mass transit to the park, size of the park, what visitors can do, where they can stay, what concession operations are available and what they provide, and the location of the parks are also included. The Guide is mostly an information service for the public.

State Recreation Supply Inventory

Inventory of recreation supply by states is conducted in conjunction with the development of statewide comprehensive outdoor recreation plans (SCORP). Several SCORP's were reviewed and found to have similar supply inventory methodologies. Differences occurred in classifications of recreation activities, categories of information collected, and the extent and method of surveys. The SCORP's of Colorado in 1976 and Montana 1975 were representative of those reviewed.

Generally, each state first conducted a survey (by interview or questionnaire) of all of the private recreational areas in the state. Information was collected concerning size of the area, visits per year, season of use, activities and facilities available, location, and sometimes fees and admissions charged. Information concerning recreational areas on state and federal lands was generally collected from the agencies responsible for those lands. All the data was then complied and tabulated according to the needs of each state.

Colorado employed a team of students from Colorado State University to conduct the inventory for its 1976 SCORP. The team visited every private outdoor recreation area, facility, or enterprise in Colorado. Seven categories of information were collected for each site and tabulated on special mark-sense forms. The seven categories were: (1) geographic location, (2) ownership and administration, (3) Bureau of Outdoor Recreation (BOR) land class, (4) the type and quantity of specific facilities and activity opportunities available, (5) information on five-year acquisition and development plans, (6) user capacity for each specific facility or activity, and (7) the length of the operation season per year. The BOR land classes range from Class I high density recreation areas to Class V primitive areas and Class VI historic and cultural sites.

The data was then compiled and displayed in several tabular forms in the SCORP. Listings were made of number of areas by region, by administration, by ownership, by BOR land class, and by activities offered. This data was also compared to that collected in 1970, listed by counties.

Montana's inventory of recreation supply for its 1975 SCORP was based on data collected in 1964 for the Nationwide Outdoor Recreation Plan. Representatives of the Montana Fish and Game Department contacted all of the counties and nine of the cities in the state. Information was received from 51 of the 56 counties, and seven of the cities contacted. The categories of data collected included acreage, physical characteristics of the areas, recreational activities, and facilities on the areas. Data for federal recreational areas was collected from the Bureau of Outdoor Recreation.

The data was then compiled and presented in a format similar to that for Colorado. Listings were made by district, and by type of activities, such as playfields and ski areas. Montana used a BLM numbering system which described the locations of each site listed.

The U.S. Forest Service Recreation Information Management System

The U.S. Forest Service Recreation Information Management system (RIM) of data collection was implemented in 1965. It is a system of managing information about recreation sites under Forest Service management, about the facilities located on those sites, and about the use of those sites by visitors.

The data for RIM is collected in several ways according to the type of recreation site involved. Information about developed sites, such as campgrounds and picnicgrounds, is collected by the manager of the site. A statistical sampling technique is used whereby visitors are counted at different times in the season, along with data such as their state of residence, their destination, and the length of their visit. Information from the ski areas is collected by ski area management through ticket and concessions sales.

Information about dispersed recreation is subjectively estimated in many cases. Registration cards are often used on wilderness trails on which a visitor lists information such as his/her state of residence, his/her destination, the length of his/her visit and the number in his/her party. The parking lots for dispersed areas are often sampled for an estimated number of visitors. Car counters placed on roads to trailheads are also used to estimate the number of visitors.

The RIM system is capable of producing several types of output. The Basic Address describes developed and dispersed sites as far as location, ownership, site kind, acreages, Bureau of Outdoor Recreation classes, and construction accomplishments on the site. The Directory lists directions to each site, the facilities available there, and the fees charged. A Facility Condition section lists the quantity and condition of items in place on the site, (i.e., satisfactory, substandard, replace, eliminate) and information about costs per visitor day to operate and maintain the sites. The Recreation Use and Sampling portions of the output contain data concerning the number of visitors to each site, the number of visitors in different activity classes, and several listings of use by site kind, by charge classes, and by administrative unit. These last two sections are comprised of the estimates discussed earlier.

The accuracy of RIM data depends upon the kind of site for which it was collected and upon the amount of time and money available to spend on its collection. Data from the developed sites and ski areas is probably the most accurate. These sites require close and constant maintenance which facilitates fairly accurate sampling. Dispersed recreation, however, is difficult if not impossible, to sample. Problems arise because of time, money, and staff--all are insufficient for the extensive sampling on which RIM depends.

As a management tool, RIM is useful on a large-scale basis. It is helpful in determining trends and areas of concentration for an entire region or for the nation. It can be useful on a particular forest in determining areas and seasons of use, and to some extent the kinds of users visiting. Problems arise in considering particular sites or groups of sites on a forest. No data found in RIM addresses what affect a certain management action will have on the use or non-use of a particular recreation area. An example of such a problem occurs on Shadow Mountain Reservoir. The Forest Service is considering closing one of the islands on the reservoir to provide for osprey nesting grounds. The RIM data available was not useful in determining the use of the island by visitors, what type of recreation occurs there, and especially what affect this management action would have on the recreation on the reservoir. It simply was not specific enough (Tyler, 1981).

The RIM system as originally developed is a method of managing recreation information. It can be a useful management tool when considered broadly. It has limitations, however, in two areas. The time and money required for better accuracy is not available, and the specificity required for smaller scale managing is not provided by RIM.

The Recreation Opportunity Spectrum (ROS) as Implemented by the U.S. Forest Service

The Recreation Opportunity Spectrum Model (ROS) used by the U.S. Forest in conjunction with the RIM system is a recreation classification system which assumes first that people have preferences for recreation experiences and do choose between them, and second that these preferences are not based solely on the activities offered. The other factors are represented in a hierarchy of demand for certain types of opportunities. The term "demand hierarchy" is used because people are often unaware that they demand opportunities which are on a "higher" level. Consequently, the higher levels of demand are more difficult to measure.

Level one of the hierarchy is the demand for recreation activities, or activity opportunities (AO). This level of demand is the most obvious to users and managers, and is the one by which most recreation planning and management has been conducted.

Level two is the demand for certain setting opportunities (SO). A setting is made up of the physical, social, and managerial attributes of an area. For example, a fisherman may prefer to fish a wildland stream (physical) with few signs of other recreation users (social) in an unrestricted area (managerial).

Level three represents the demand for certain psychological outcomes, or states of mind, that occur from participation in a certain activity in a preferred setting. Examples of these desired outcomes are enjoying the out-of-doors, taking risks, developing and applying skills, and getting exercise. A recreation user will have a set of desired psychological outcomes for a given activity in a preferred setting. This set of psychological outcomes is collectively termed an experience opportunity (EO).

The fourth level of the hierarchy represents the demand to realize lasting benefits that result from participating in an activity in a preferred setting and realizing beneficial outcomes. An example would be the health benefits from a long hike in the wilderness. These benefits can be realized by the participant, or by society because of his participation.

The ROS incorporates these demand levels into an array of recreation opportunities, based on activity and experience opportunities that are appropriate for specific settings. Because many activities can be performed in a given setting, the experience opportunity component of the spectrum becomes a major determinant of recreation supply. For example, the experience, or set of psychological outcomes, resulting from fishing an undisturbed alpine lake is much different from that of fishing in a city park lake. Driver and Brown (1978) say: "only by defining the types of experience opportunities that are most likely and possible in a given environment can an explicit differentiation between activities be made."

Therefore, an inventory of recreation supply using the ROS considers very specific physical, social and managerial attributes of an area, the experience opportunities most likely to occur in that setting, and the activities which will provide those experiences. Table 1 lists each class of the ROS and its subsequent experience, setting, and activity opportunities. Present development of the ROS system has resulted in a useful "recreation land classification system." That is, it is possible to utilize the system to identify lands that are best suited for each of the ROS categories of opportunities. Further, it provides a useful set of guidelines for management once a ROS class has been assigned to a particular tract of land.

BLM Recreation Supply Inventory

The Bureau of Land Management is also in the process of implementing a Recreation Opportunity Spectrum (ROS). The ROS has been specifically defined to be "a continuum of recreation opportunities which range from total resource dependency to total facility dependency" (BLM Manual Supplement, Release 1-110). Six classes of recreation opportunity have been defined on the spectrum, based on physical, social and managerial aspects.

The Primitive opportunity class is defined at the "total-resource-dependency-end" of the spectrum. Areas in this class are physically unmodified and fairly large in size. There is very little evidence of other users, and contact between groups of users is uncommon. The areas are free from managerial restrictions and controls, and facilities are provided only for the protection of resources.

The Modern Urban opportunity class is defined at the other end of the spectrum. These areas are highly modified physically. They are designed to accommodate large numbers of visitors, and evidence of other users is predominate. Managerial controls and restrictions are obvious, and facilities are provided for the use and convenience of visitors.

Table 1. The Recreation Opportunity Inventory and Classification Spectrum, with the Associated Experience Opportunity Classes and ther Associated Physical, Social, and Managerial Setting Requirements.

Opportunity Class	Experience Opportunity	Physical, Social, and Managerial Setting.
Primitive (P)	Opportunity for isolation (from the sights and sounds of man), to feel a part of the natural environment, to have a high degree of challenge and risk, and to use outdoor skills.	Area is characterized by essentially undmodified natural environment of fairly large size. Concentration of users is very low and evidence of other area users is minimal. The area is managed to be essentially free from evidence of man-induced restrictions and controls. Only essential facilities for resource protection are used and are constructed of on-site materials. No facilities for comfort or convenience of the user are provided. Spacing of groups is informal and dispersed to minimize contacts with other groups or individuals. Motorized use within the area is not permitted.
Semi-Primitive Non-Motorized (SPNM)	Some opportunity for isolation from the sights and sounds of man, but not as important as for primitive opportunities. Opportunity to have a high degree of interaction with the natural environment, to have moderate challenge and risk, and to use outdoor skills.	Area is characterized by a predominantly unmodified natural environment of moderate to large size. Concentration of users is low, but there is often evidence of other area users. The area is managed in such a way that minimum on-site controls and restrictions may be present, but are subtle. Facilities are primarily provided for the protection of resource values and safety of users. On-site materials are used where possible. Spacing of groups may be formalized to disperse use and provide low-to-moderate contacts with other groups or individuals. Motorized use is not permitted.

Table 1. (cont.)

Opportunity Class	Experience Opportunity	Physical, Social, and Managerial Setting
Semi-Primitive Motorized (SPM)	Some opportunity for isolation from the sights and sounds of man, but not as important as for primitive opportunities. Opportunity to have a high degree of interaction with the natural environment, to have moderate challenge and risk, and to use outdoor skills. Explicit opportunity to use motorized equipment while in the area.	Area is characterized by a predominantly unmodified natural environment of moderate to large size. Concentration of users is low, but there is often evidence of other area users. The area is managed in such a way that minimum on-site controls and restrictions may be present, but are subtle. Facilities are primarily provided for the protection of resource values and safety of users. On-site materials are used where possible. Spacing of groups may be formalized to disperse use and provide low-to-moderate contacts with other groups or individuals. Motorized use is permitted.
Roaded-Natural (RN)	About equal opportunities for affiliation with user groups and opportunities for isolation from sights and sounds of man. Opportunity to have a high degree of interaction with the natural environment. Challange and risk opportunities are not very important. Practice and testing of outdoor skills may be important. Opportunities for both motorized and non-motorized forms of recreation are possible.	Area is characterized by predominantly natural environment with moderate evidences of the sights and sounds of man. Such evidences usually harmonize with the natural environment. Concentration of users may be low to moderate with facilities sometimes provided for group activity. Evidence of other users is prevalent. Controls and regimentation offer a sense of security and are on-site. Rustic facilities are provided for convenience of the user as well as for safety and resource protection. Moderate densities of groups is provided for in developed sites and on roads and trails. Low to moderate densities prevail away from developed sites and facilities. Renewable resource modification and utilization practices are evident, but harmonize with the natural environment. Conventional motorized use is provided for in construction standards and design of facilities.

Table 1. (cont.)

Opportunity Class	Experience Opportunity	Physical, Social, and Managerial Setting
Semi-Urban (SU)	Opportunities to experience affiliation with individuals and groups are prevalent as is the convenience of sites and opportunities. These factors are generally more important than the setting of the physical environment. Opportunities for wildland challenges, risk taking, and testing of outdoor skills are unimportant, except for those activities like downhill skiing in which challenge and risk taking are prevalent.	Area is characterized by substantially modified natural environment. Renewable resource modification and utilization practices are primarily to enhance specific recreation activities and to maintain vegetative cover and soil. Sights and sounds of man are readily evident, and the concentration of users is often moderate to high. A considerable number of facilities are designed for use by a large number of people. Facilities are often provided for special activities. Moderate to high densities of groups and individuals are provided for in developed sites, on roads and trails, and water surfaces. Moderate densities are provided for away from developed sites. Facilities for intensified motorized use and parking are available.
Urban (U)	Opportunities to experience affiliation with individuals and groups are prevalent as is the convenience of sites and opportunities. Experiencing natural environments, having challenges and risks afforded by the natural environment, and the use of outdoor skills are relatively unimportant.	Area is characterized by a substantially urbanized environment, although the background may have natural elements. Renewable resource modification and utilization practices are to enhance specific recreation activities. Vegetative cover is often exotic and manicured. Soil protection usually accomplished with hand surfacing and terracing. Sights and sounds of man, on-site, are predominant. Large numbers of users can be expected both on-site and in nearby areas. A considerable number of facilities are designed for the use and convenience of large numbers of people and include electrical hookups and contemporary sanitation services. Controls and regimentation are obvious and numerous. Facilities are provided for special activities. Facilities for highly intensified motor use and parking are available with forms of mass transit often available to carry people throughout the site.

The first step is a comprehensive inventory of recreation information for the area of interest. Specifically, the BLM collects: (1) physical resource information such as soils, climate, and vegetation; (2) recreation features information such as scenery, wildlife, and geologic features; (3) information about existing recreation developments and operations on BLM lands as well as surrounding private, state, and federal lands; and (4) visitor-use data on BLM lands, other federal lands, state lands, and private lands. Socio-economic recreation data, which deals with economic values and relative significance of the resource base to the regional and national economy, is collected by an economist/sociologist. The data involves use levels and trends, the relative importance of use levels to the region, state, and nation, and the expenditures made by visitors.

This information is then used to classify land areas into units of Activity Opportunities and Setting Opportunities, which together provide certain Experience Opportunities. As noted above, an Activity Opportunity (AO) is the opportunity to engage in a specific activity of group of activities on a given area. These are determined by delineating land areas into Ecological Land Units (ELUs), which are relatively homogeneous areas in terms of physical resource attributes and associated recreation features. Delineation is based on logical divisions in the character of the land-examples are mesa-tops, valleys, hills, wooded areas, and parks. Each ELU is then ranked into AO classes ranging from class 1 for very high capability and intensive use to class 7 for very low capability and very dispersed use. The areas are then further classified according to the dominate recreation features found on them. These classes are lettered from A to Z and include such features as river access units, vegetation cultural resources, landforms, winter upland slopes, and wetland wildlife. The classes together represent an ELU's capability for providing certain recreation activities.

Delineating the AOs and SOs (as defined above) on separate maps, and then overlaying them produces an array of Recreation Opportunities (ROs). Again, an RO is the opportunity to engage in a particular activity, in a particular setting, to realize particular psychological outcomes that define a predicable experience (BLM Manual Supplement, Release 1-110). This final delineation represents the supply of recreation opportunities on a certain land area.

As with the U.S. Forest Service applications of the ROS system, the BLM application results in a recreation land classification of the area under study. It should be noted that the BLM application of the ROS system includes elements of the land classification system developed by Hills (1961).

ECONOMIC SUPPLY ANALYSIS OF RECREATION

Very little progress has been made in the economic supply analysis of recreation. Both land allocation analysis and program development and budgeting analysis have been hampered by the inability to describe the incremental costs associated with incremental outputs. Granted that attempts have been made in both areas of analysis, the assertion here is that the analytic difficulties have not been adequately addressed.

Two problems that need to be solved if useful approximations of the economic supply of recreation outputs are to be made available to resource policy makers are: (1) definitions of and measurements of recreation outputs must be made more precise than they currently are, and (2) linkages between recreation outputs and resource inputs (land, labor, and capital) must be determined.

Measuring Recreation Outputs

The ROS system has been generally adopted by both the BLM and the USFS, but little progress has been made in estimating use or output in the dimensions suggested by the ROS system. For example, semiprimitive nonmotoroized (SPNM) opportunities are a type of recreation "resource" class which are of interest to recreation and policy managers. Yet, estimates of the output of SPNM opportunities from a proposed resource complex are seldom if ever available. Often, estimates of the number of visitor days (RVD's) of remote camping, fishing, etc., are made. While these are useful bits of information, they do not "measure" the outputs of ROS-defined opportunities which managers are supposedly managing.

Furthermore, the estimates of the outputs of RVD's are often "professional judgements." Very little objective information is available to describe the level of opportunity that would become available as a result of implementation of a proposed recreation project. This problem is never severe when developed facilities such as campgrounds, boating ramps, and ski lifts are analyzed since estimates of "capacity" can be used as the estimate of output. The problem is most unmanageable in the case of dispersed use such as hiking, camping, wildlife related use, etc.

The difficulty seems to lie in the measurement instruments available and the funding available to carry out available measurement technology. Both considerations combine to insure that very poor estimates of output are available.

Production Function and Supply Schedule

In what follows, production functions are reviewed; the application of production function logic to optimization type analysis is suggested; and finally the possibility of estimating aggregate supply functions for recreation opportunities with optimization techniques is discussed. Draft Chapter 560 of the USFS 1901 manual says, "The forest's supply information is not described by a traditional economic supply schedule but rather through a set of multi-resource plan alternatives that represent a wide range of production possibilities and expenditures."

It is clear that the definition of supply contained in Draft Chapter 560 could be used to construct a schedule of the marginal costs of producing incremental bundles of outputs. Thus the major difference between what Chapter 560 requires and what elementary textbooks define as the market supply schedule is that the supply-cost schedules required in the forest planning process are for bundles of outputs instead of a single output.[10] Additionally, it is expected that results will be displayed as totals instead of incremental changes from some base level of activity (i.e., minimum level of management). Note that it is straightforward to construct the incremental tables given that the base level (i.e., minimum) is defined.

To establish the linkage between the discussion of recreation opportunities and economic supply analysis of recreation, it is useful to review cost and production analysis. A simple production and cost model for recreation might be stated as:

$$0_i = f(X_i, 0_j)$$

$$MPP_{X_i} = \delta 0_i / \delta x_i$$

$$MC_{0_i} = \frac{P(X_i)}{MPP(X_i)}$$

where 0_i is the output of the ith recreation commodity,

X_i is the level of the ith input $\quad i = 1.....n,$

0_j is the output of other commodities $\quad j = 1.....n,$

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[10] It should be noted that there would be a different supply-cost schedule for each unique set of output targets or fetters. That is, if the targets are changed, the supply-cost schedule will be different.

MPP_{X_i} is the marginal cost of producing the ith output given that the ith input is the only variable in production, and

$P(X_i)$ is the price of the ith input.

For a firm or a forest, the marginal cost schedule is the supply schedule. If more than one firm or forest is involved in the analysis, the aggregate supply schedule is the horizontal summation of the firm schedules. An important thing to note about this simple formulation of a supply schedule is that the levels of outputs other than the one being analyzed are fixed.

Supply analysis for a true joint production system, such as a National Forest, is more complex then the simple model allows since the supply-cost schedules of the several joint products will be interdependent. The implication of this is that supply-cost schedule for a single output such as SPNM experiences will not be unique. There will be "n" possible supply-cost schedules corresponding to the "n" different combinations of output levels of the other commodities. Thus, the long-run supply schedule will have to be represented by a schedule of the bundle of outputs that result from various levels of management intensity. Put in another way, the supply-cost schedule will be the schedule of outputs that result when alternatives reflecting a range of resource outputs and expenditure levels and which are the most cost efficient combination of management practices examined that can meet the objectives established in the alternative are described. This is a case where the size of the factory is being changed by adding additional resources, and the most cost efficient combination of outputs for each level of resource input or alternatively expenditure is related to that expenditure level.

SUPPLY ANALYSIS OF RECREATION WITHIN THE OPTIMIZATION CONSTRUCT

The intent of supply cost analysis, as defined in Chapter 560, is to portray the incremental costs of moving to successively higher levels of "management intensity" with each level being characterized by unique bundles of output.

In the case of a forest, the planning and analytic problem is the need to formulate alternative forest management plans which reflect "various levels of management intensity."

Linear Programming and the Formulation of Alternatives

The building blocks of a linear programming model structured to analyze land allocation and output scheduling are the feasible management prescriptions.[11] It should be noted that "feasible management prescriptions" are usually formulated for each significantly different type of land unit included in a management area. It should also be noted that it is critical to include management prescriptions which describe a "range of management intesities" for each land subunit included in the analysis. By utilizing Sessions (1979), formulation of a forest land management problem, the linkage between linear programming procedures and supply analysis can be illustrated. Sessions presents the following model:

Max	$\sum_{A} Bi - Ci$	(Maximize NPV)
Subject		
To	$\sum_{A} V_{it} \geq VV_t$	(Timber volume targets)
	$\sum_{A} O_{it} \gtrless R_t$	(Nonmarket Resource Outputs Targets)
	$\sum_{A} C_{it} \leq K_t$	(Forest Budget)

[11] A management prescription is a set of practices that are scheduled through time to achieve specific output objectives.

Let: O_i represent the nonmarket outputs for management prescription i

t represent the time period in which the management practice occurs

C_i, B_i represent the discounted costs and benefits associated with management prescription i

A_j represent an analysis area

K_t represent a budget constraint for the entire forest time period t

V_{it} be timber volume otuput of management prescription i in period t

VV_t be the timber output goal of the forest plan alternative in period t

R_t be the minimum or maximum output for nonmarket resources in time period t for either an analysis area or the entire forest

This analytic structure allows development of supply cost schedules as defined above for the long run case. Procedurally, a unique schedule results from solutions to a linear programming model (each set of unique output targets yields a unique model) with alternative budget levels. It is also important to recall that each supply cost schedule will be a description of management intensities or costs relative to the associated output bundles. They will not be simple relationships between marginal costs of production and associated levels of a single outputs.

Given this structure, each solution to the linear programming problem is a forest alternative plan. This alternative plan is composed of specific management prescriptions scheduled for specific tracts of land in specific time periods. Associated with each of these alternative plans are unique output bundles and unique costs of operation. Since these alternatives are the building blocks for the supply cost analysis, the range of alternatives considered becomes critical to the completeness of the supply cost analysis. There are two general guidelines that can be used in the development of forest alternatives. One relates directly to the types of alternatives needed, the with-and-without rule; and the other relates to the types of prescriptions that should be incorporated into the linear programming model.

The With and Without Rule

Since the generation of supply cost schedules focuses on changes or marginal conditions, a base must be defined which can be used for comparisons. Gregerson (1980) suggests the following example (Figure 2) to illustrate the concept.

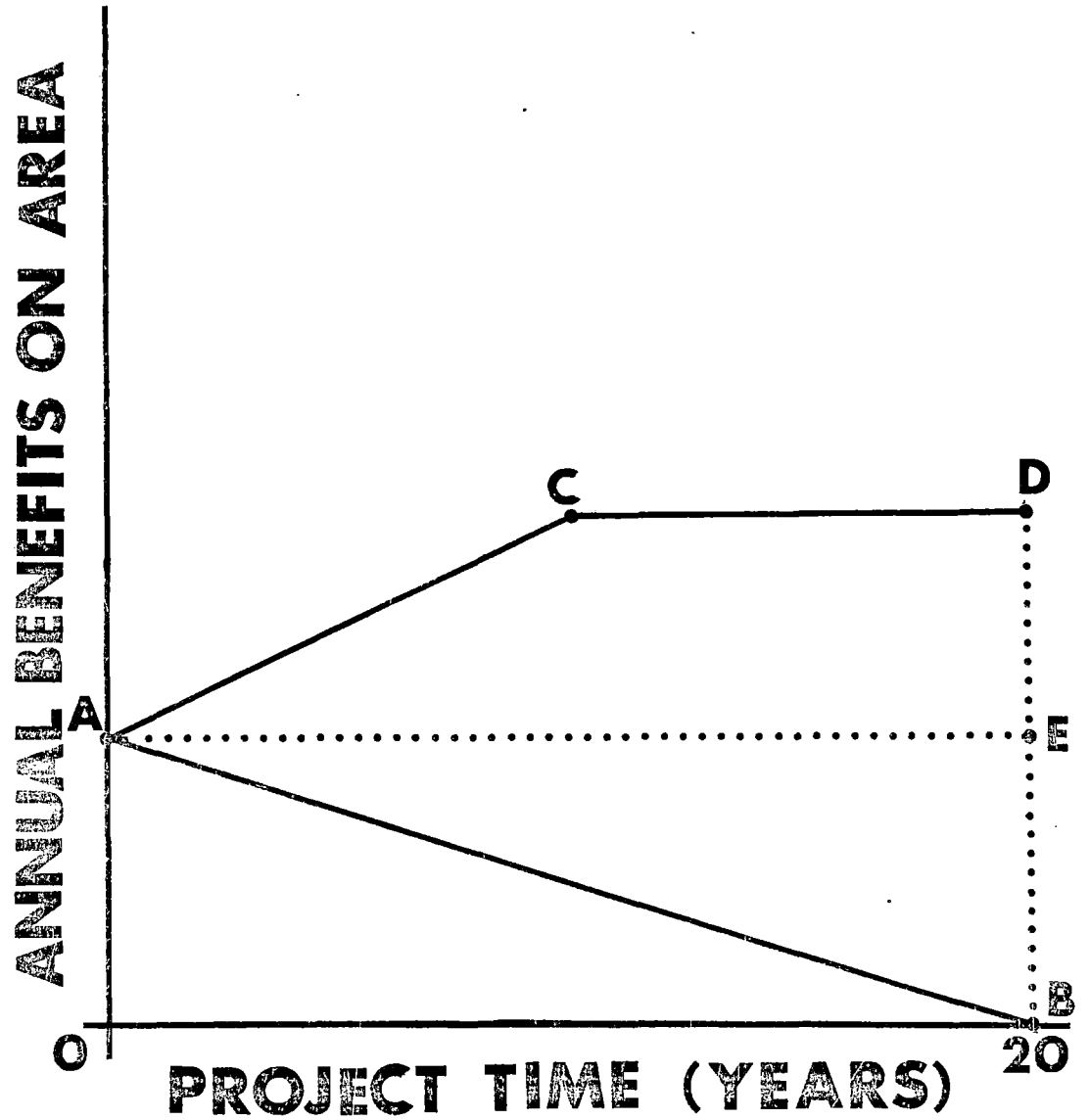

FIGURE 2. THE WITH AND WITHOUT RULE ON A SOIL PROTECTION PRESCRIPTION

Figure 2 describes the consequences of two alternative plans. The vector AB describes the path of annual benefits if the minimum level of management (without project) is implemented, and the area OAB is a statement of the total benefits over the life of the analysis. The vector AE described the situation if everything remains as it is (i.e., annual benefits of OA). The vectors AC and CD describe the path of benefits if the plan or project under consideration is implemented, and the area ACDE is a statement of the total benefits in excess of those that would result over the current level if the level of benefits did not change from the current levels. It is critical to note that no alternative resulting in AE has been cast up for analysis. Only the project ACD has been offered as an alternative to the no action alternative AB. Thus, the difference between the proposed alternative's total benefits (OACDB) and the no action alternative's total benefits (OAB) is equal to the area ABEDC. It is tempting for many analysts to conclude that the area AEDC is the incremental benefit, but this is clearly not the case. It would be possible to cast up an alternative that would maintain the benefits at an annual level of OA. The incremental benefits of this alternative would be the area ABE, and in no case does the area AEDC become a statement of the incremental benefits of the project. It would be the increment above the alternative that maintained the existing condition, but it is not the appropriate benefit estimate to bring into the benefit-cost approximation of economic efficiency analysis.

To illustrate the relevance of this point to forest plan economic analysis, it is suggested that the current level management alternative will correspond to AE in Figure 2, the minimum level of management corresponds to AB, and that each alternative under consideration will correspond to ACD. Note that it is likely that some of the alternatives considered would produce benefits which result in a schedule of benefits that will be below the current alternative. This is not a problem, but it serves to illustrate the importance of defining a minimum level of management as the appropriate base for analysis.

Management Prescriptions as the Building Blocks for Forest Alternatives

Chapter 1970.5 of the U.S. Forest Service Manual defines management prescriptions as:

> management practices selected and scheduled for application on a specific area to attain multiple-use and other goals and objectives

Sessions (1979) developed the example prescription in Table 2 to illustrate what a simple single purpose prescription would look like. Note that this simple example is only for illustration purposes, and that a realistic management prescription would be significantly more complex. This would be particularly true of the list of inputs or practices and the schedule of outputs.

The particular rules used to formulate prescriptions are important if the economic analysis of them is to be as useful as possible. Two are of particular importance. Again, the first involves establishing the linkage between inputs and outputs.

Table 2.--A simple management prescription

Year	Inputs: Management practice	Inputs: MIH code	Cost ($/AC)	Outputs: Receipts ($/AC)	Outputs: Volume (MBF)	Other
0	Harvest-Slash Disp.	249	-3000	6640	40.0	--
0	Site Prep	234	- 60			--
1	Plant	230	- 200			--
6	Release	277	- 30			--
14	Precom Thin	264	- 95			--
41	Com Thin	249	- 400	1600	6.5	--
51	Com Thin	249	- 350	1500	5.9	--
76	Harvest-Slash Disp.	249	-2160	12900	36.0	--

Stating a rule that it must be possible to define the inputs and outputs that describe a prescription seems redundant at first glance. Most technical staff sense that they can do this with little effort. Implementation, however, is often more difficult than one senses. Seldom do planners or analysts define management activities in the detail implied by Table 2. Reference to Table 2, the management prescription, makes clear why it is so important to specify the inputs and outputs of a prescription. Without a very precise statement about what the inputs and outputs of a prescription are, it would be impossible to develop estimates of the supply cost associated with the prescription; and thus it would be impossible to complete a supply cost analysis.

The second rule for developing prescriptions that will be discussed here involves the concept of the smallest separable unit. The purpose of this rule is to make sure that prescriptions are not lumped together in the analysis. The difficulty encountered is that in some cases an efficient prescription will make an inefficient prescription look acceptable if they are lumped together. That is, the positive net benefits of the good project will off-set the negative net benefits of the bad project, and the combined project will appear acceptable from an economic efficiency point of view. Gregersons (1980) example has been modified (Table 3) to illustrate this point.

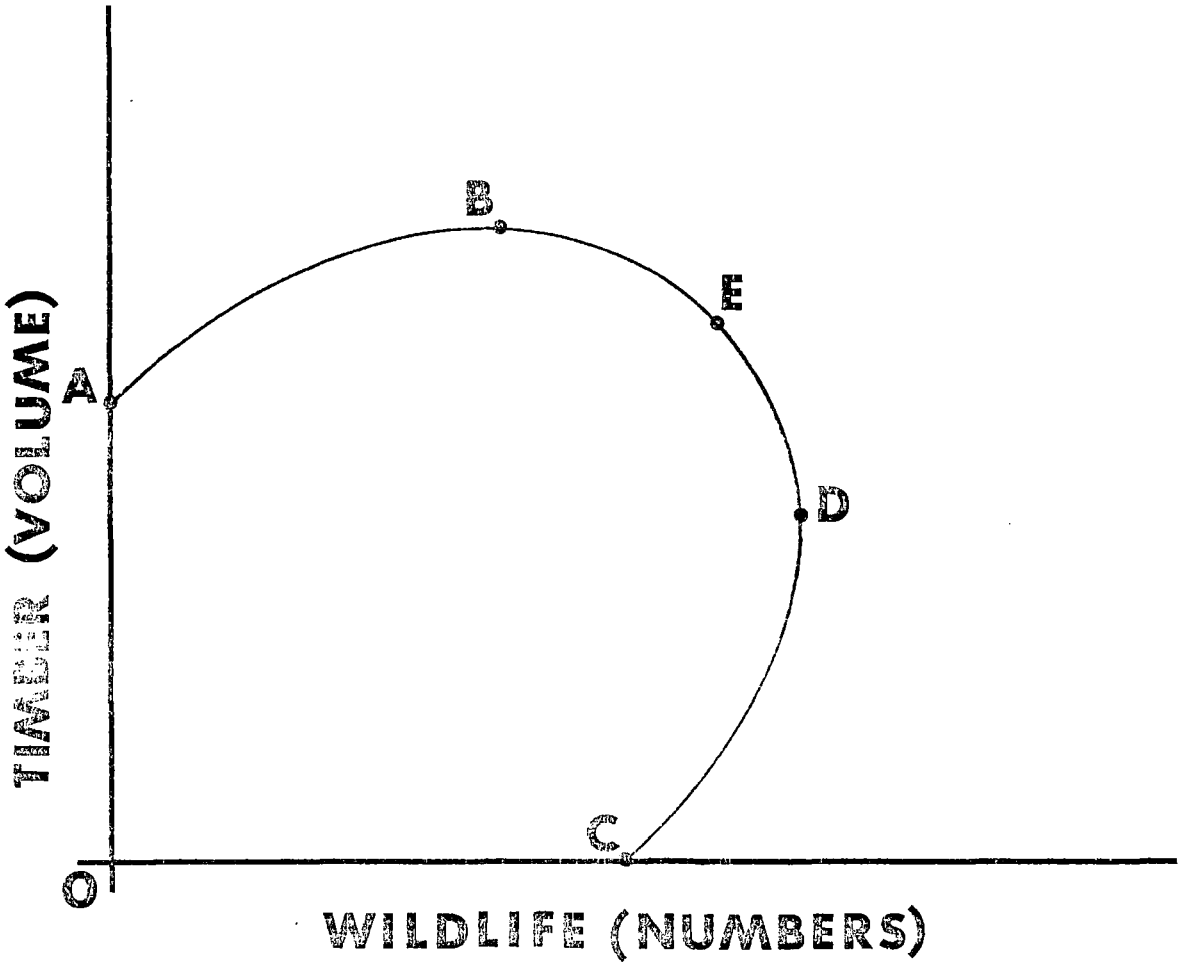

FIGURE 3. PRESCRIPTIONS IN A JOINT PRODUCTION SYSTEM

Points A, B, C, D, and E represent the outputs of alternative sets of prescriptions for the forest complex and fixed bundles of resources being considered. Prescription set A might well be the prescription that the timber staff designed without regard for the wildlife component of the problem and the wildlife staffs' thoughts. Prescription set B might be the prescription that the timber staff designed using some of the inputs from the wildlife staff. For example, the wildlife staff may have suggested the possibility of undertaking some overstory removal action in protected wildlife habitat zones to enhance forage production. This suggestion plus the timber intensive action included in A lead to increase in both wildlife and timber outputs. Similarly, prescription set C might be the prescriptions that the wildlife staff developed without consultation with the timber staff. Prescription set D might be the prescriptions developed after discussion with the timber staff which involved some thoughtful harvesting practices on lands not previously thought of as wildlife habitat.

The message which is immediately obvious is that in cases of joint production, it is usually fruitful to explore joint production prescriptions. In fact, reference to an intermediate textbook in microeconomics will yield the conclusion that only the prescriptions that are joint in nature are relevant. Stated differently, only the prescriptions that result in output combinations described by the production possibility frontier between prescriptions B and D in Figure 3 are relevant to analysis. Choice of any prescriptions outside of this set results in inefficient management.

Types of Prescriptions Necessary to Carry Out the Supply-Cost Analysis and Their Structure

Chapter 1920 of the USFS manual, section 1922.21b defines Analysis Areas, and suggests that this subdivision of a forest is the focus of prescription development. In fact, the expectation is that a range of prescriptions (10-20) will be tested on each analysis area. From discussion above, it follows that for each analysis area the following categories of prescriptions could be considered:

1. the minimum level of management
2. the unconstrained maximum level
3. the constrained maximum
4. constrained minimum
5. minimum acceptable
6. maintenance level
7. RPA assigned
8. various joint product strategies
9. current direction, and
10. prescriptions responsive to issues and/or concerns.

The example in Table 2 was developed upon the assumption that management practices would form the building blocks for management prescriptions. Thus, for each prescription type listed above, the interdisciplinary team (ID team) must specify which practices would have to be implemented to carry out the prescription. Further, the timing of these practices must be specified. This becomes particularly important when the process and results of discounting calculations are considered. Specification of the appropriate set of management practices and their timing is essentially a technical set of questions that resource specialists must answer. Similarly, the puzzle resulting from the need to specify the outputs and their timing is a technical problem.

Developing Cost Estimates for Prescriptions

Important components of supply cost analysis within a linear programming framework are the cost estimates assigned to the management prescriptions. As pointed out above, management prescriptions are composed by scheduling specific management practices through time. Thus, the task of assigning costs must be organized around practices that compose each prescription. Table 2 is an illustration of the types of practices that can be grouped to formulate a prescription. Table 2 also includes cost estimates for each of the practices. The question of how these cost estimates can be developed is not easy to answer. The problem derives from a lack of historic information on costs of practices applied over the range of circumstances encountered in analyzing feasible management prescriptions. There is simply not enough reliable information to leave one comfortable with most cost estimates. Two general types of approaches are suggested by most analysts working on the problem: (1) review of available information, and (2) interviewing knowledgeable specialists.

When available information is utilized, procedures are available. The most common approach is to examine the data that seems to apply best to a given set of circumstances (i.e., vegetation type, slope, soil, etc.), and to use the simple average as a indicator of the cost of applying the particular practice to that set of circumstances. The alternative approach focuses on a sample of the available data, and often utilizes regression analysis to deal with projecting the cost data over range of circumstances.

The interview-of-experts approach is used when either there is no data available or the cost of obtaining data is very high. The process involves identifying a group of people who have unique experience with the management practice being analyzed. Once the knowledgeable group is identified, the analyst attempts to elicit the group's "best" estimate of the cost.

Recent experience in the U.S. Forest Service land management planning process has made very clear the difficulty of obtaining cost estimates that all can agree are accurate. The general conclusion can be stated that; without better record of the costs of implementing specific practices, the task of assigning costs will remain subjective and thus uncertain.

DERIVATION OF SUPPLY SCHEDULES WITH ECONOMETRIC MODELS

A procedure which suggests itself as an alternative to the optimization procedure outlined above is application of econometric techniques to aggregate data describing the recreation market. Stated simply, there is assumed to be a recreation market such that:

$$D = f(P, x_i)$$

$$S = f(P, y_i)$$

$$D = S$$

Where D is the quantity demanded,

P is the price of the recreation commodity,

the x_i are other demand determinants,

S is the quantity supplied, and

the y_i are other supply determinants.

This model has not been applied successfully in cases where the aggregate marginal cost schedule for the market is the analytic end. There are several obvious reasons for the absence of any successful results:

1. there are factors in the recreation market which affect recreation supply more than the marginal costs of production. Thus historic data offer little information on the marginal costs of production,
2. the measurements of both the quantity of output and the costs of producing have been poor, and finally and perhaps most important,
3. there are simply no adequate data to estimate such a model with.

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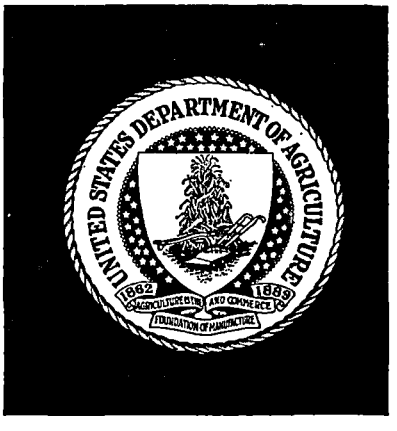

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